Data Inter-Networking to Optical Transmission Networks

Presentation to: DARPA

Data in the Optical Domain Workshop

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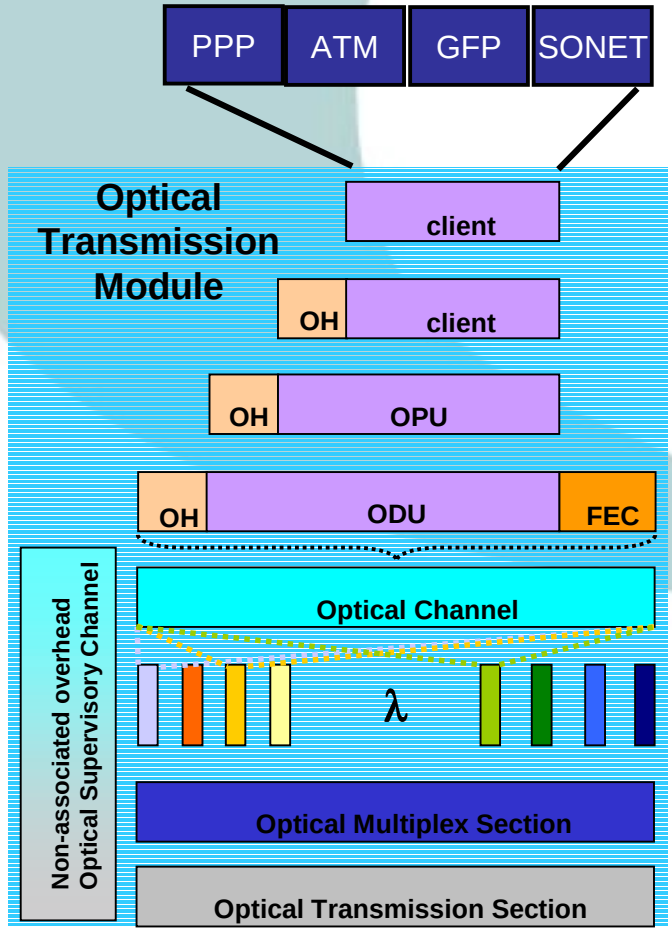
By Gerard Jankauskas, VP Systems Architecture, Bay Microsystems

Data Inter-Networking to Optical Transmission Networks

- Bay Introduction
- OTN Reference Architecture
- Network View
  - Access and switching networks
    - Tunnel and Terminate & Transmission
  - Network interconnection
    - Mediation and OTN E/O (Electrical-to-Optical) Client adaptation
  - Security
    - Support End-End and trunk encrypted Networks
    - Network Monitoring
- Applications
  - Data Plane
  - Control Plane
- Bay Technology Overview & Application
- References

OTN Architecture



OPU

ODU

OTU

OCh

OMS

OTS

Optical Channel:
Provides end-to-end networking of optical channels for transparently conveying client information of varying format (e.g. SONET, SDH, cell-based ATM, GFP, etc.)

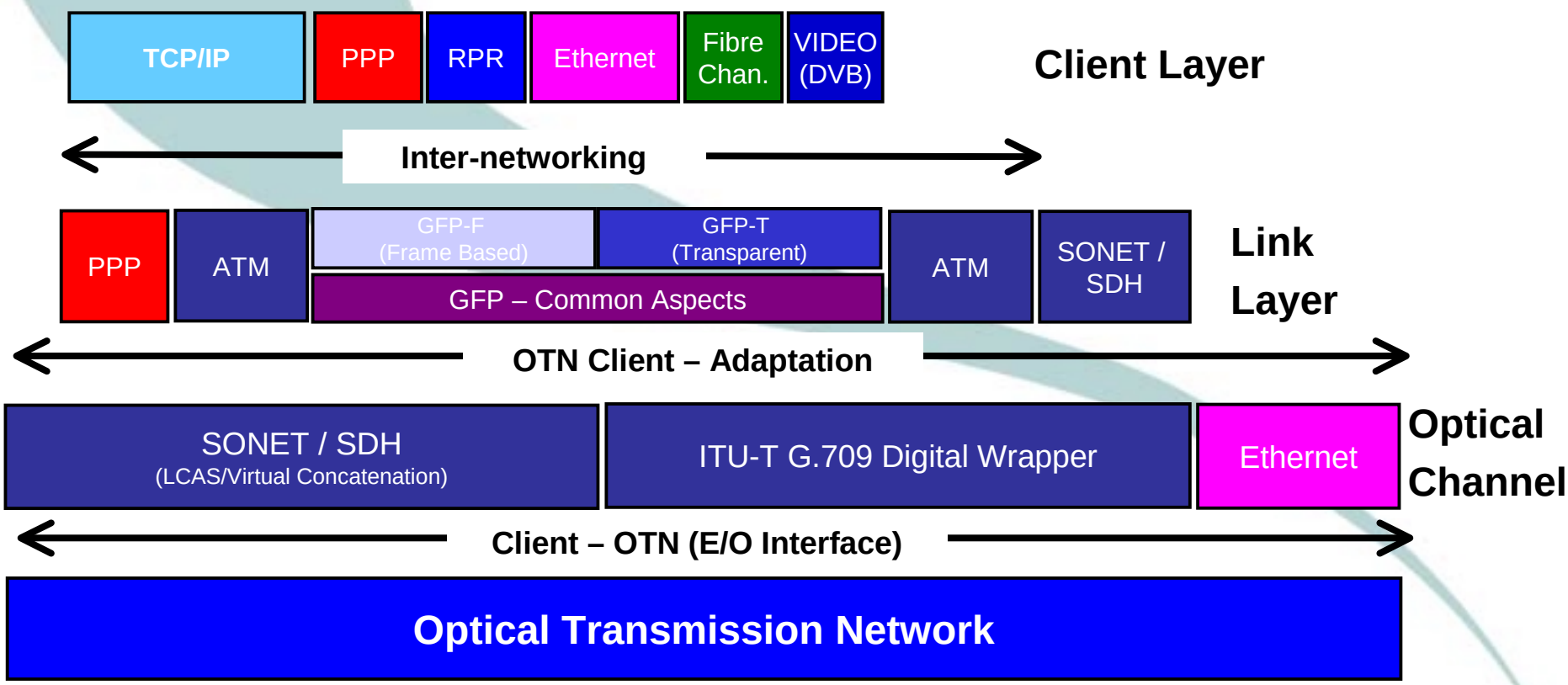
Optical Multiplex Section:
- Supports the connection monitoring and assist Network Admins providers in troubleshooting and fault isolation
- Describes optical DWDM connection between two components with multiplex functions e.g. OXC, OADM

Optical Transmission Section:
- Describes transmission on an optical link between two components
- Used for maintenance and operational functions
- Allows the network operator to perform monitoring and maintenance tasks between NEs

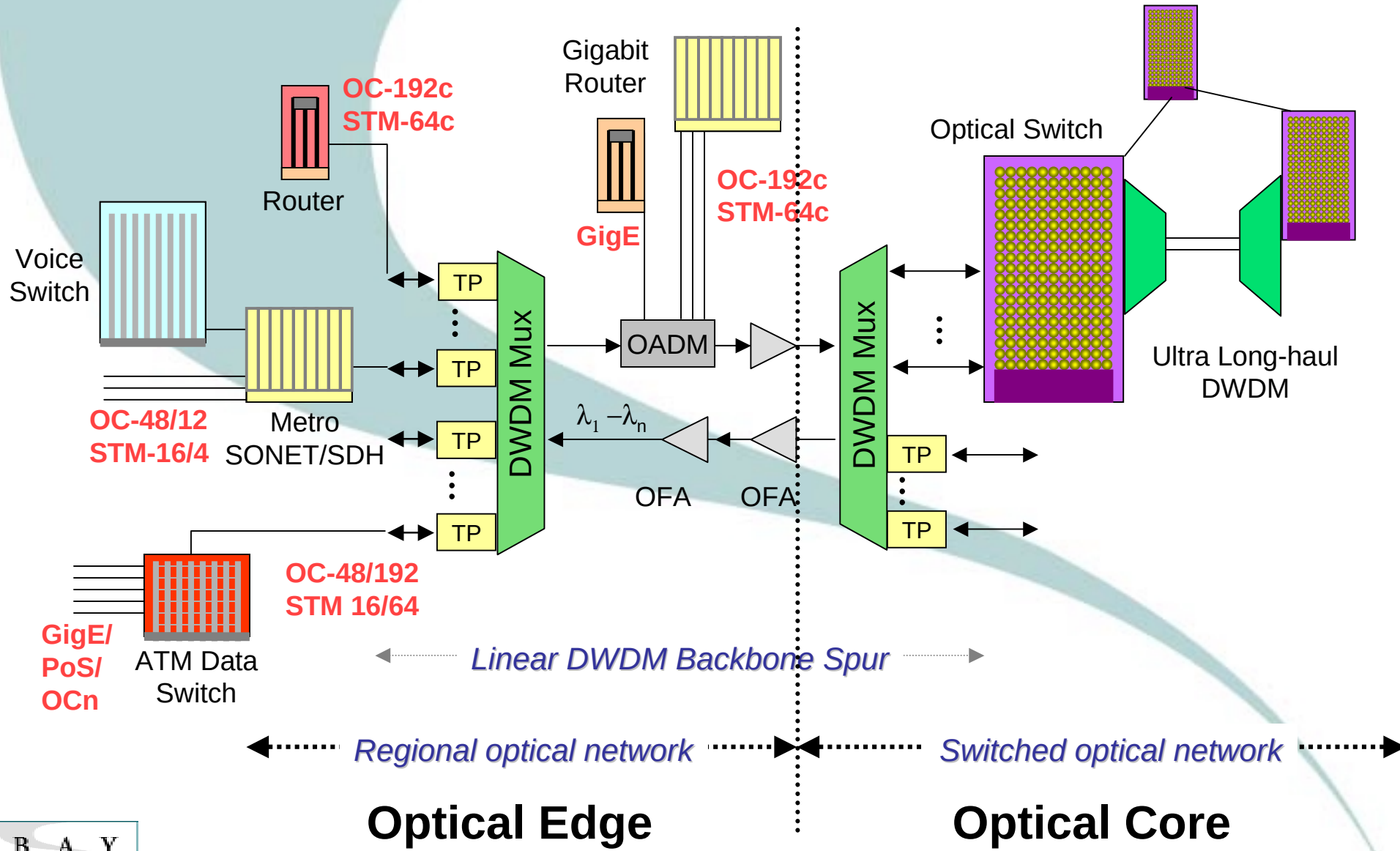
OCh = Optical Channel
ODU = Optical Data Unit
OPU = Optical Payload Unit
OTU = Optical Trans Unit

From ITU-T G.709 & G.874

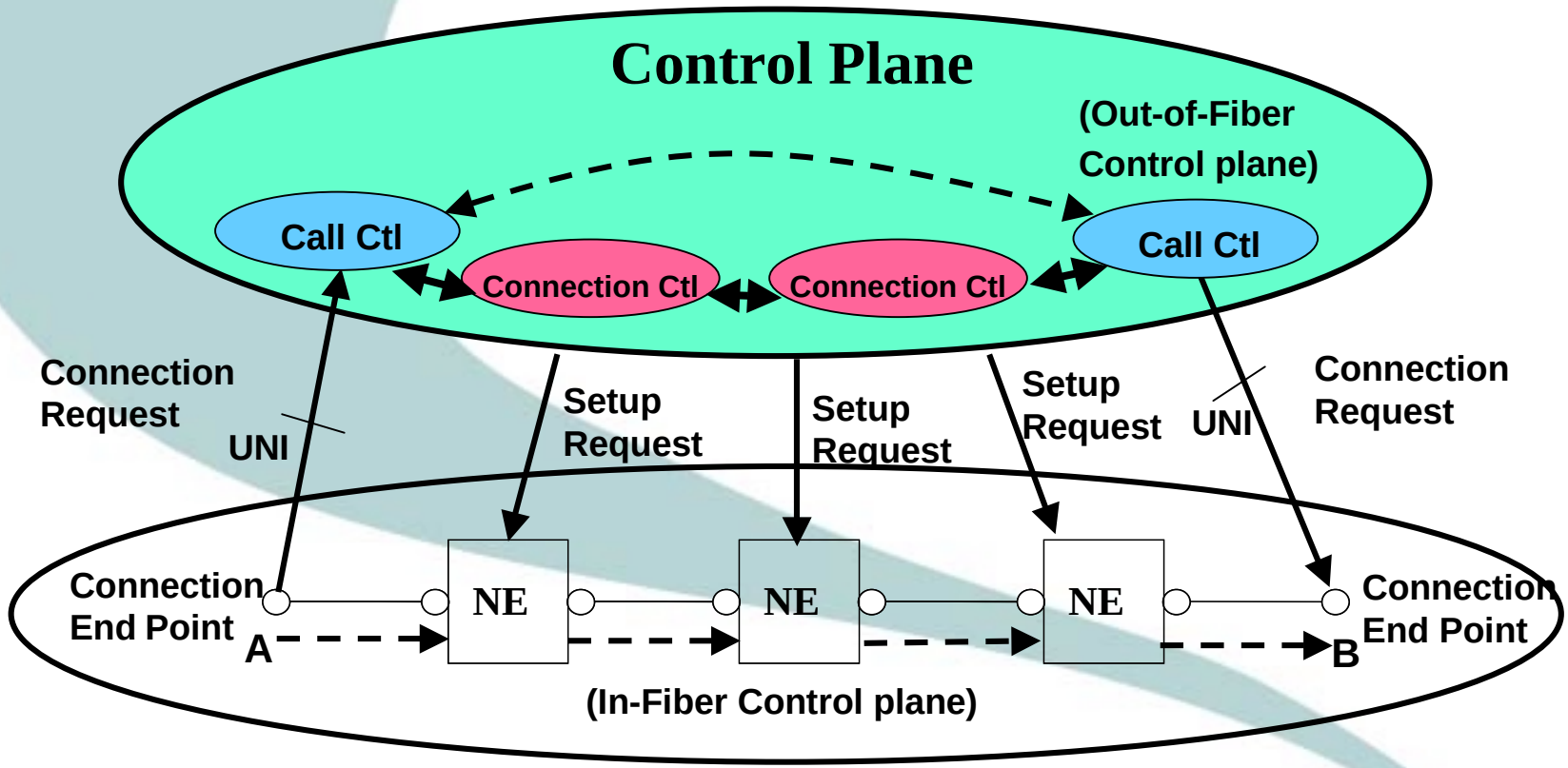
Client to Optical Channel Mapping



Sample OTN Deployment



OTN Control Plane Architecture(s)
(ITU-T, IETF & OIF)



Control Channel Operations

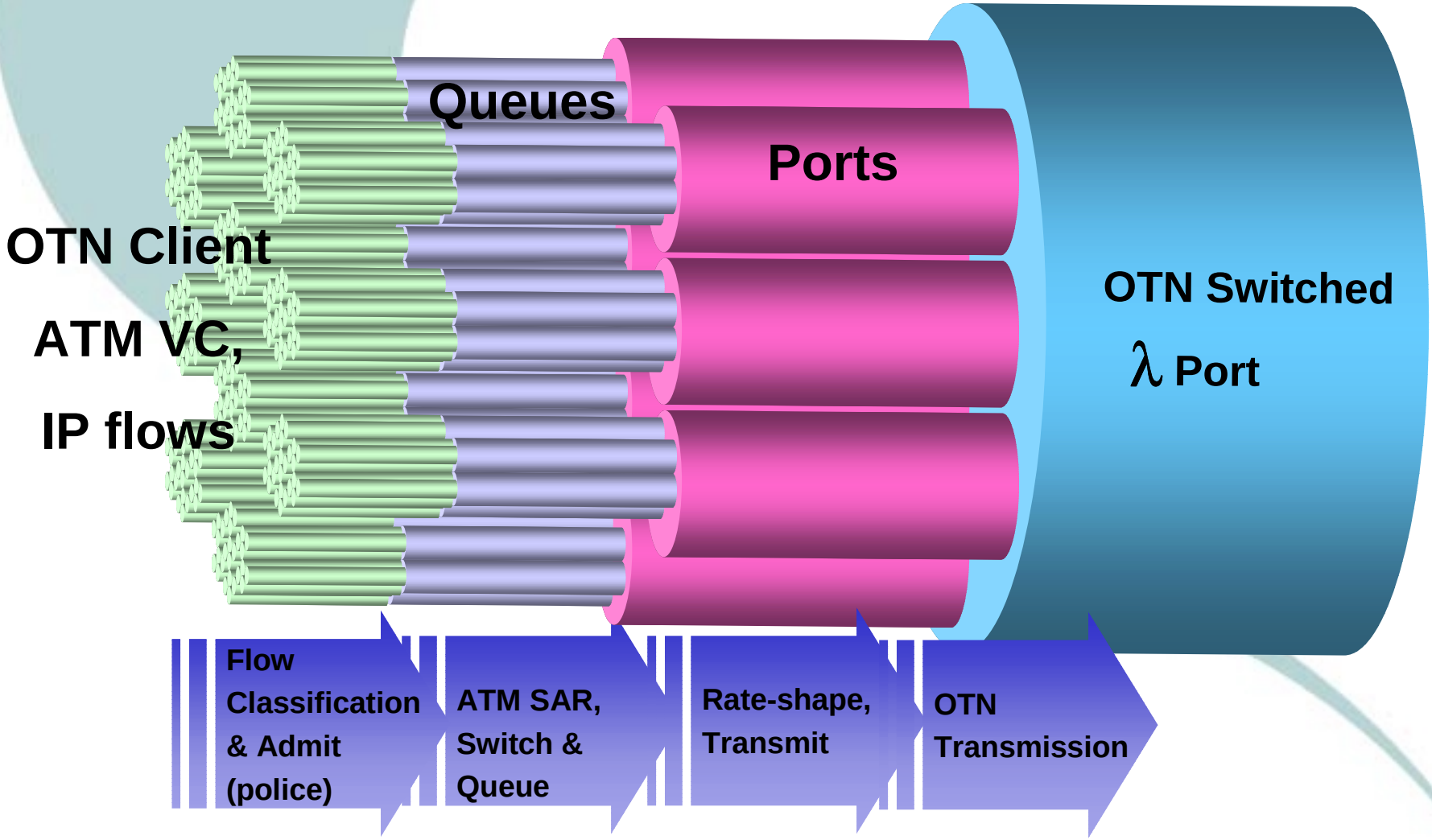
- L2 and L3 (IP) forwarding
- In-band (fiber) Peer forwarding on Embedded & Optical Control Channels
- Out-of-band (fiber) Virtual Private Networking (Ethernet)
- Differentiated Quality of Service
  - Classification of Alarm, Call Control, Routing, Performance Monitor traffic
- Traffic Management/rate-shaping
  - Rate Adaptation to DCC/ECC

From ITU-T G.807 ASTN Architecture

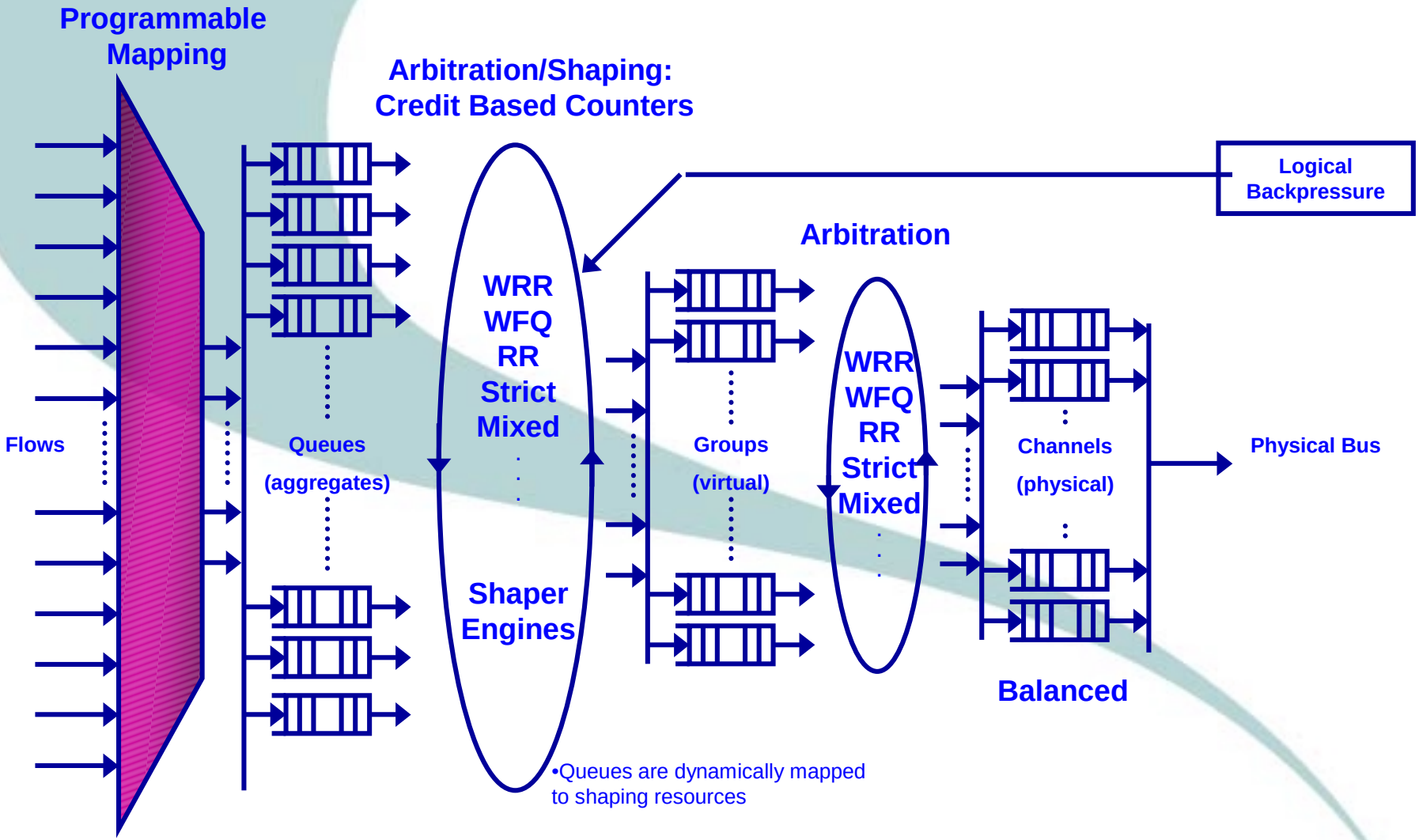
OTN Data Network Operations

- Data-plane- Client
  - ✧ Handle very High-speed Aggregated Optical Data Interfaces
    - —Inter-networking
      - Classification & Protocol Adaptation & ATM SAR
    - —Logical Channel (VCC) switching
    - —Statistical Multiplexing
      - Maximize Digital Channel Efficiency
    - —Traffic Management
      - Policing, Rate Shaping
    - —Security
    - —Network Recovery
    - —Monitoring & Accounting
- Control-Plane
  - ✧ IETF GMPLS & ITU-T ASON
    - —Require Data-forwarding and QoS & Traffic Management functions

Aggregation of VCCs for Transport



Hierarchical Implementation of Aggregation functions



Bay Processing Elements

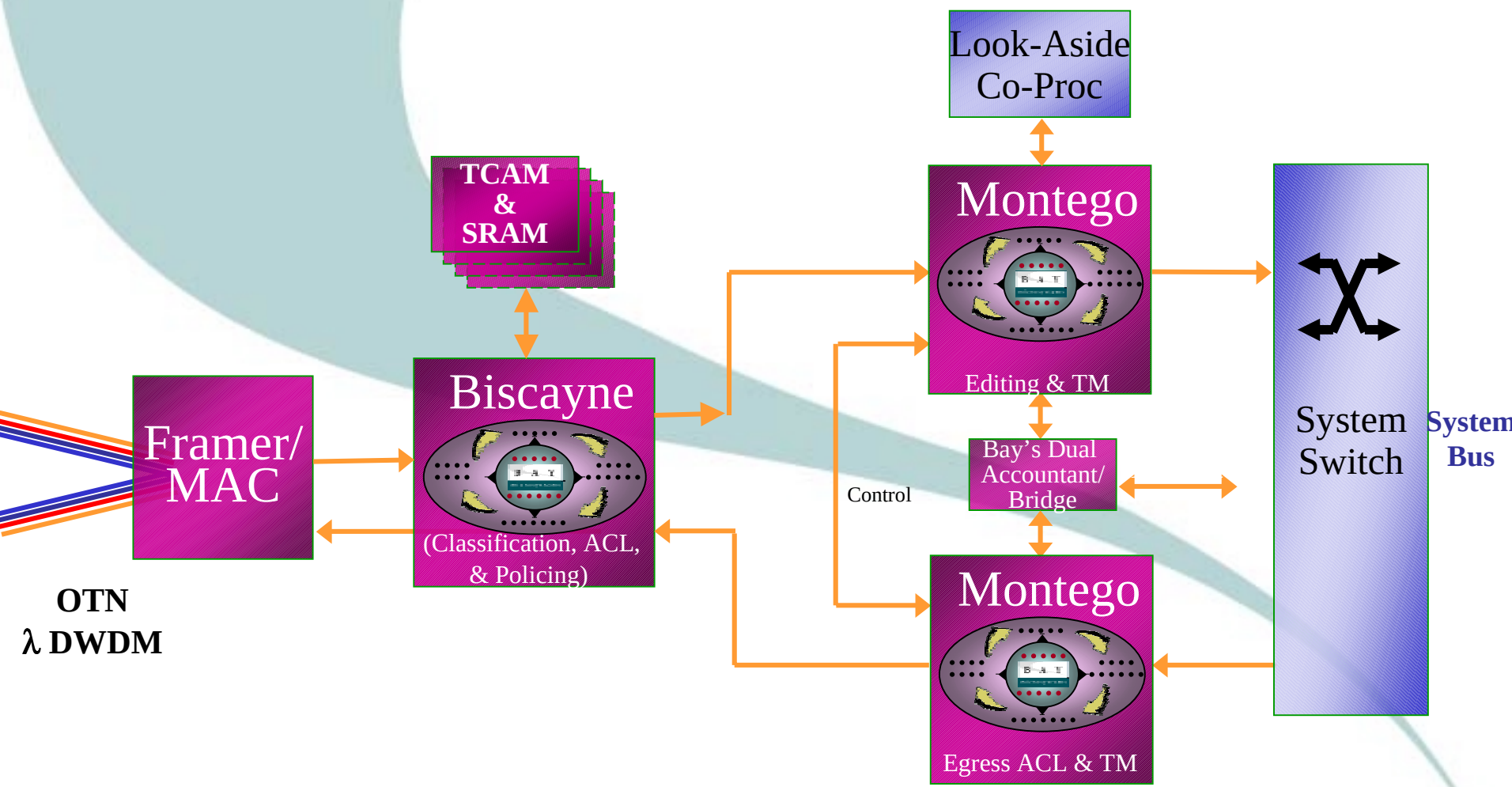
Montego 10(16)Gbps:

- Network Interworking
  - AnyMapping Forwarding
  - 16Gbps Shared Memory Switch Architecture
  - Programmable packet/segment based editing
    - Packet, cell, segment operational modes
- Traffic Shaper
  - Hierarchical Scheduler
    - Work conserving and non work conserving
  - Per-channel CoS (Packet / Cell)
    - WFQ, Strict Priority, WRR, RR, Mixed
  - Rate shaping (Packet / Cell)
    - granularity of < 1 Buffer/Cell per second
  - Per VP, VC Shaping (Cell)
    - CBR,VBR, UBR+, UBR
- Classification
- Policy Engine
  - AAL5 SAR
  - Policing, Marking/Metering
  - Congestion Management (WRED, PPD, EPD)
- Forwarding Engine
  - Multicast support
  - Variable Size Packet Segmentation

Biscayne 10Gbps Classifier:

- Deep packet inspection
  - Deep Cell/Packet classification
  - Recursive looks (2 paths) per packet Direct, internal & external CAM
- Control plan forwarding based on classification
- Virtual table searches
  - VPN bits brought forward from previous search and bits for what stage in the lookup for tunneling and virtual CAM tables
- Support for Ethernet (Rapid) Spanning Tree, SA learning, MAC (and ARP) aging
- Fast active/standby table swap
- ACL & System rules
  - DoS attack as an application
- ATM AAL5 Start-of-Packet classification without SAR
- Cell and frame-relay/Ethernet policing and ATM & DiffServ 3-color marking on up to 1 million flows
- Per counters and checking

Line Termination/Network Interface Design



Network Applications

- **Network Applications**
  - Network Interconnect & Mediation
    - — Goal: Provide Efficient Channel Capacity & Protocol Agility
  - Block Encryptor Adaptation (ATM SAR)
  - Network Monitor
    - — Security, Performance, Operations Management
  - Grid Computing
    - — Computational & Data Grids interconnect
- **Network Implementation**
  - Optical switching: OEO or OO
  - Circuit switching
  - L2 switching
  - L3 routing
- **Network Element Applications**
  - Protocol Independent Encryptor
  - Network Adaptor/Extension
  - Network-to-Network inter-working
  - Control-plane forwarding processor

References

ITU-T:

- **Requirements & Architecture**
  - G.874 – Requirements for Optical Transport Networks
  - G.807 – Requirements for the Automatic Switched Transport Network
  - G.8080 – Architecture for the Automatic Switched Optical Network
- **Detailed Requirements and Protocols**
  - G.709 & G.707 – Interface for OTN & Interface for SDH
  - G.7712 - Architecture and Specification of Data Communication Network
  - G.7713 - Distributed Call and Connection Management
    - G.7713.1 – PNNI based
    - G.7713.2 – RSVP-TE based
    - G.7713.3 – CR-LDP based
  - G.7714 - Generalized Automatic Discovery Techniques
    - G.7714.1 – Protocol for Automatic Discovery in SDH and OTN Networks
  - G.7715 – Architecture and Requirements for the Automatically Switched Optical Network
    - Substantial interest in starting a protocol specification

IETF:

- **Requirements & Architecture (ccamp, ipo, mpls working groups)**
  - draft-ietf-ccamp-gmpls-architecture-04.txt - GMPLS (LDP & RSVP-TE)
  - draft-ietf-ipo-carrier-requirements-05.txt
  - …

OIF:

- OIF-UNI-1.0
- OIF-NNI

Thank you